"A PANEL AND RELATED WALL STRUCTURE"

TECHNICAL FIELD

The present invention relates to a panel and related wall structure and in particular to a sound absorbing panel and structure which although not essentially but, preferably is used as a building panel such as a wall or ceiling panel.

BACKGROUND ART

Wall and ceiling panels made of a gypsum based material are well known. Such panels are often also called plaster board panels and consist of a core of gypsum material overlaid on each side by a paper sheet. Such panels are used placed against framing timber to provide a lining for an interior surface of a room of a house or building or the like. Similarly suspended ceilings may be provided wherein the plaster board is suspended from a framing structure to thereby reduce the degree of vibrational transmission of sound.

Such additional steps in providing a further sound proofing can however be costly and it is advantageous if a single sheet of a building panel can be provided wherein significant or adequate sound absorption effects are provided by that panel alone. It will be appreciated that the provision of intermediary sound absorbing members add steps to the installation procedure of lining a room of a building.

The sound transmission loss of wall-barriers is determined by physical factors such as mass and stiffness. In double layer assembly, as in gypsum wallboard on non-continuous wood framing, the depth of air space, the presence of sound absorbing material and the degree of mechanical coupling between layers critically affect sound transmission losses and therefore the sound transmission class (STC).

Renewed interest in reducing noise in living chambers has motivated research in structural-acoustic analysis. Sound is generated by creating disturbance of the air which sets up a series of pressure waves fluctuating above and below the air's normal atmospheric pressure. These pressure waves propagate in all directions from the source of the sound. There are many sources of sound in buildings: voices, human activities, external noises such as traffic, entertainment devices and machinery. They all generate small rapid variations in pressure about the static atmospheric pressure. These propagate through the air as sound waves. The nature of excitation may be unique to each chamber. The sound transmission loss of wall-barriers is determined by physical factors such as mass and stiffness. In double layer assembly, as in gypsum wallboard on non-continuous wood framing, the depth of air space, the presence

of sound absorbing material and the degree of mechanical coupling between layers critically affect sound transmission losses and therefore the sound transmission class (STC). The internal sound field in the enclosed area is significantly affected by: the acoustic modal characteristics, the dynamic behaviour of the surrounding structure, and by the nature of the coupling of these two dynamic systems e.g. that created by wall and ceiling structures. In addition, depending upon the relative value of the wall panel and gap resonant frequencies, sound transmitted from one side of a wall to the other may be amplified rather than reduced.

It is common knowledge that for typical partitions, the transmission loss is much smaller for low frequency sounds than for high frequency sounds.

SUMMARY OF THE INVENTION

Accordingly it is an object of the present invention to provide a panel which overcomes the abovementioned disadvantages or which at least provides the public with a useful choice.

It is also an object of the present invention to provide a wall structure which has improved acoustic transmission properties over single panelled wall structures, or to at least provide the public with a useful choice.

Accordingly the present invention consists in a panel comprising a unitary wall or ceiling panel comprising

a first layer predominantly of a solidified gypsum based material and of a non cavity defining structure, said first layer defining a first exterior major surface of the panel and

a second layer of a solidified gypsum based material having a plurality of preferably substantially homogenously provided cavities, said second layer engaged with the first layer and disposed from the side of said first layer opposite to said first exterior major surface,

said cavities each including anhydrate material of a kind having a water content dependent volumetric displacement, said cavities having been formed by the volumetric shrinking of said anhydrate material resultant from the dissipation of water from said unitary panel gypsum wet phase precursor during its curing to a solidified state.

Preferably said second layer is engaged directly to said first layer.

Preferably a third layer is provided as part of said panel capturing said second layer between said first and third layer, said third layer being of a solidified gypsum based material of a non cavity defining structure and defining a second exterior major surface of said panel.

Preferably said third layer is substantially similar to said first layer.

Preferably said first, second and third layers are coextensive.

Preferably at least one of said first and second major surface of said panel is provided with a patterned non planar surface.

Preferably at least one of said first and second major surface consists of a plurality of upstands.

Preferably each said upstand is prismatic in shape.

Preferably at least one of said first and second major surface of said panel is a cobbled surface.

Preferably said first and third layer is substantially of gypsum.

Preferably said third and first layers include EVA additive.

Preferably said first and third layers include a fibre re-enforcing material .

Preferably said anhydrate material is a polyacrylate.

Preferably said anhydrate material is a potassium polyacylate.

In a further aspect the present invention consist in a method of providing a unitary wall or ceiling panel which comprises the steps of

a) providing a layer of wet pre-solidified phase gypsum based material and anhydrate material homogenous mixture, onto a layer of wet pre-solidified phase gypsum based material without said anhydrate;

b) allowing curing to a solidified phase of said gypsum to occur.

Preferably the method further includes the provision of a layer of wet pre-solidified phase gypsum based material onto to the exposed surface of the layer of pre-solidified phase based gypsum and anhydrate material homogenous mixture.

Preferably the method further includes the provision of a layer of gypsum based material onto the exposed surface of wet pre-solidified phase gypsum and anhydrate material homogenous mixture by the dispersing of a gypsum based power form material onto the the exposed surface of wet pre-solidified phase gypsum and anhydrate material homogenous mixture.

Preferably said third mentioned layer is absent of anhydrate material.

Preferably said anhydrate is a polyacrylate.

Preferably said polyacrylate is potassium acrylate.

Preferably said third mentioned layer prior to it setting is screeded to provide a planar surface finish.

Preferably a fibrous material is provided in at least one of the first and third mentioned layers.

Preferably said fibrous material is fibreglass.

Preferably said second mentioned layer is applied onto a horizontal moulding surface which during the curing of said layers provides upward support to said layers.

Preferably said moulding surface has an patterned relief moulding surface to impart a non planar surface to said second mentioned layer.

In a further aspect the present invention consist in a wall structure of a building comprising

a vertically extending frame work spanning between a floor and ceiling of said building

a wall panel subassembly comprising a first panel and at least one other panel

said second panel engaged to said first panel in a substantially parallel manner and separated therefrom to define a space there between, said first and second panels engaged to each other in a separated manner by a compressible material spacer element,

wherein said subassembly is mounted from and affixed to said frame work by mechanical fastening means in a manner wherein said first panel is positioned facing said frame work and wherein a compressible material spacer element in provided intermediate of said first panel and said framework.

Preferably said first and second panels are coextensively engaged with each other.

Preferably said first panel comprises

a first layer predominantly of a solidified gypsum based material and being of a non cavity structure, said first layer defining a first exterior major surface of the panel and

a second layer of a solidified gypsum material having a plurality of substantially homogenously provided cavities, said second layer engaged with the first layer and disposed from the side of said first layer opposite to said first exterior major surface,

said cavities each including anhydrate material of a kind having a water content dependent volumetric displacement, said cavities having been formed by the volumetric shrinking of said anhydrate material resultant from the dissipation of water from said unitary panel gypsum wet phase precursor.

Preferably said second panel is of a homogenous gypsum based structure.

Preferably the surface of said first panel facing said frame structure side is non planar.

Preferably said surface of said first panel facing said frame structure is of a cobbled or prismatic texture.

Preferably said compressible material spacer is a strip material and extends at least proximate to the perimeter of and between the first and second panels.

Preferably a second wall panel sub assembly is provided and disposed from the other side of said frame work, said second wall panel sub assembly comprising a first panel and at least one other panel

said second panel engaged to said first panel in a substantially parallel manner and separated therefrom to define a space there between, said first and second panels engaged to each other in a separated manner by a compressible material spacer element,

wherein said second subassembly is mounted from and affixed to said frame work by mechanical fastening means in a manner wherein said first panel is positioned facing said frame work and wherein a compressible material spacer element is provided intermediate of said first panel and said framework.

Preferably the distance between the first panel of said first wall panel subassembly and the first panel of the second wall panel sub assembly is approximately 170 mm.

Preferably said frame work comprises of vertically extending timber studs.

Preferably said frame work comprises two parallel and separated rows of studs a first row with which the first sub assembly is engaged and a second row with which said second sub assembly is engaged.

Preferably said first panel of said first sub assembly and said first panel of said second sub assembly each included a cobbled or prismatic surface detail.

In still a further aspect the present invention consists in a wall or ceiling panel assembly comprising

a first planar panel of a rigid sheet material

a second planar panel of a rigid sheet material affixed to said first wall panel in a spaced apart disposition from said first wall panel, wherein the major surfaces of said first and second planar panels are parallel and in at least a significant overlapping relationship with each other

at least one resiliently flexible element disposed between the facing major surfaces the first and second panels and sealing engaged to the facing surfaces of each panel,

wherein at least one of said first and second panels (hereinafter the "cavity panel") comprises

a first layer predominantly of a solidified gypsum based material and of a non cavity defining structure, said first layer defining a first exterior major surface of the panel and

a second layer of a solidified gypsum based material having a plurality of preferably substantially homogenously provided cavities, said second layer engaged with the first layer and disposed from the side of said first layer opposite to said first exterior major surface,

said cavities each including anhydrate material of a kind having a water content dependent volumetric displacement, said cavities having been formed by the volumetric shrinking of said anhydrate material resultant from the dissipation of water from said unitary panel gypsum wet phase precursor

a third layer predominantly of a solidified gypsum based material and of a non cavity defining structure, said third layer defining a second exterior major surface of the panel.

Preferably at least one of the first or second exterior major surfaces of said cavity panel(s) is of a non planar surface consisting of plurality closely or abuttingly spaced upstands.

Preferably one of the first or second exterior major surfaces of said cavity panel(s) is of a non planar surface consisting of plurality closely or abuttingly spaced upstands.

Preferably only one of said first and second panels is a cavity panel.

Preferably the exterior (to said assembly) facing major surface of said cavity panel is of a non planar surface consisting of plurality closely or abuttingly spaced upstands.

Preferably the major surface of said cavity panel facing the other of said first and second panels is of a non planar surface consisting of plurality closely or abuttingly spaced upstands.

Preferably said resiliently flexible element is a strip material and is provided between the first and second panels at or immediately inwardly of the overlying perimeter regions of said first and second panels.

Preferably said first and second panels are affixed to each other in a substantially coextensive relationship.

BREIF DESCRIPTION OF THE DRAWINGS

This invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

Figure 1 is a sectional view through a preferred form of the panel of the present invention,

Figure 2 is a side view of a panel of the present invention,

Figure 3 is a sectional view through an installation which includes the panel of the present invention to define a sound absorbing wall structure,

Figure 4 illustrates a means of joining adjacent panels,

Figure 5 illustrates an arrangement for supporting a panel from a vertical or horizontal surface,

Figure 6 illustrates a method of fixing a series of panels to a wall structure wherein the assembly provides enhanced soundproofing,

Figure 7 illustrates an example of an assembly of a wall utilising the panel of the present invention in conjunction with additional panels and framing,

Figure 8 illustrates a prismatic surface texture provided on the panel of the present invention,

Figure 9 is a view of the core of the panel of the present invention,

Figure 10 is an illustration of the setup of the acoustic testing room,

Figure 11 is a graph of results of the testing as hereinafter described,

Figure 12 shows a test data sheet of the wall construction incorporating the cavity panel, and

Figure 13 shows a test data sheet of the wall construction incorporating the cavity panel.

DETAILED DESCRIPTION OF THE INVENTION

The wall or ceiling panel

The proposed panel of a first aspect of the inventions described provides a convenient way of absorbing noise transmission and is maintained within a standard panel thickness (e.g. 12.5mm) commonly used in building trades. With reference to Figure 1, the face gauge (exterior layers 4 and 1) consists of a gypsum based material and provides a high density thin layer. The exterior layers 1 and 4 are of a non-cavity structure and may hence be considered of a solid non porous structure. The face gauges 1 and 4consists of a gypsum based material and provides a substantially solid thin section to the panel of the present invention. One face gauge provides its exposed surface 2 to be provided in a condition in use to be exposed into the room but which can later be subjected to further treatment such as priming and painting or for the application by adhesion of a paper layer or similar cellulosic material.

Each face gauge 1 is preferably of a high density consistency. Each face gauge is preferably in a form to provide a high density thin section to the panel and may be for example be provided by a reasonably low water content wet mix of solidified gypsum pre-cursor.

The body gauge (the interior layer 3) consists of a gypsum material mixed with anhydrite gelling material.

The gelling material is a product, which upon contact with water, results in rapid swelling as a result of electrical forces pushing the inward structure of the particle away from the centre. When water is drawn away from the polymer the particle shrinks in volume.

Post curing, cavities are formed within the body gauge. These cavities provide sound wave dissipation. Noise that flanks past the body gauge is in part reverberated back to the cavities from the backward high-density exterior surface face of the panel. As a result of the cavities within the body gauge, many entering sound waves are internally reflected and dissipated.

A first face gauge 1 is provided in a mould or onto a mould in its wet form gypsum based pre-cursor and is spread to a thickness of for example 2mm. Provided on top of the face

gauge (i.e. against the surface of the face gauge away from the to be exposed surface 2 of the face gauge is the body gauge 3. The body gauge consists of a gypsum material which has been mixed with a hydrated gelling material such as an anhydrate as potassium polyacrylate. An example of a potassium polyacrylate is that known by the trade mark TERAWET™ which is a crosslinked potassium polyacrylate/polyacrylamide copolymer which comes in the form of white granules and has a bulk density of 540± 40 grams per cubic meter. Its Ph value is somewhere between 6-6.8. Terawet™ is a product which upon contact with water results in rapid swelling as a result of electrical forces pushing the inward structure of the particle away from the centre. Small spaces are created inside the particle which attract water. When water is drawn away from the polymer the particle shrinks in volume. With the provision of hydrated potassium polyacrylate with the gypsum to define the body gauge, a substantially solid, in its wet form, layer of material is applied to the (preferably still procured form) inwardly facing surface 10 of the face gauge 1.

The body gauge may be allowed to cure along with curing of the face gauge. However preferably a third layer, a backing face gauge 4 is provided to the then upwardly facing exposed surface of the body gauge 3. The backing face gauge 4 is preferably made of a substantially similar material to the face gauge 1. The body gauge 3 may be provided in the form of 8.5mm layer intermediate of the backing face gauge 4 and face gauge. Further intermediate layers may be provided of a different kind however the most preferred form of the panel is as shown, in cross section in Figure 1.

Preferably said third layer 4 has a normal to the plane of its exterior surface projecting in the opposite direction away from said panel to the normal of the plane of the exterior surface of said first layer 1 so the panel is of a uniform thickness...

Upon the curing of the gypsum material moisture is drawn out from the wet phase of the face, backing and body gauges. As the potassium polyacrylate also contains water, upon the curing of the panel, that water is removed from the potassium polyacrylate. The potassium polyacrylate becomes dehydrated and reduces in volume. As it reduces in volume, cavities are formed within the body gauge such cavities being substantially of a size of the wet or hydrated phase of the potassium polyacrylate.

Once dehydrated, the swelled anhydrites at the core of the sheet shrinks to form small beads. The result is aerated cavities 30-40 times larger than the remaining bead of anhydrate. The dried anhydrites can re-swell to its original cavity mass when atmospheric moisture conditions are present. This phenomenon can occur repeatedly in a consistent manner.

The anhydrites within the panel will absorb and contain water ingress and release it when appropriate warm and dryer atmospheric conditions are present.

At the casting stage an anti-mould and fugal agent is added to at least the body gauge to combat the problems associated with water ingress such as product breakdown, rot, mildew and mould growth.

The application of the backing gauge to form part of the panel of the present invention, is achieved during the curing of the face and body gauge. As the curing of the face and body gauge takes place, moisture is floated to the surface of the body gauge. This moisture can be removed by the application of gypsum powder to the upper surface of the body gauge as the moisture is transferred therefrom. The application of gypsum powder to the upper surface of the body gauge provides the backing face gauge to the panel of the present invention. In order to achieve a smooth surface to the backing gauge the powdered gypsum that is applied to the surface of the body gauge is smoothed by for example a screed. The thickness of the backing gauge can be built up appropriately to cover the upper surface of the body gauge and to thereby define a panel which is of a desired thickness. By way of example, the thickness of the panel may be provided to approximately 12.5mm.

Cavities in the body gauge, provide a disruption of reverberation of sound through the panel. The panel allows for mild reverberation of the face gauge allowing for a reasonably high percentage of noise to pass through to the body gauge. The reverberation of sound in the body gauge can be captured in the cavities in providing a dissipating effect of the noise. Noise that flanks past the body gauge is in part reverberated back to the cavities from the exterior layers. As a result of the cavities within the body gauge of the panel of the present invention, much sound that enters therein is internally reflected and eventually some if not most is absorbed.

To provide strength to the panel, fibre rovings may be provided throughout the panel or provided within at least one of the gauges and preferably within the body gauge 3.

The panel of the present invention with the inclusions of a dehydrated anhydrate will also provide some degree of humidity or moisture absorption.

Further additives may be provided to the gypsum material for the purposes of hardening and such materials may include EPA and EP hardener and indeed anti-mould or antifungal agents may be added particularly considering the possibility of moisture absorption being provided by the anhydrates.

In designing the wallboard several factors were taken into account. These include the right weight for swelled anhydrites, the right amount of a typical hardener (EP hardener) which is added to both the face and body gauges, the fibre-glass strands. Table 1 shows one example of material detail. Table 2 shows an alternative. Table 2 gives weight values of components for the improved mix at a mass quantity gauge ratio of 100 : 60.

The panel of the present invention may further be provided with a surface modification to at least one of the outwardly facing surfaces of the face gauge or backing face gauge 1,4. Such a surface modification is by way of a pattern of upstands or substantially the entire of the surface and provides a disruption to the otherwise flat exterior surface of the panel.

The panel of the present invention provides a convenient way of absorbing some noise transmission through the panel while still allowing it to be maintained within a standard thickness wall panel which are commonly used in the building trade.

With the provision of surface modifications to at least one and alternatively to both of the outwardly facing surfaces of the panel of the present invention, further sound reducing characteristics may be catered for. Surface upstands which may be provided as a pattern to the surface of the panel can provide further sound deflection. With reference to Figure 3, the panel is provided as part of a sound absorbing structure and the surface modifications 12 may be provided exposed into a cavity which is defined between the panel of the invention and an other like or other type of panel 13.

Wall Structure

The overall function of a wall, in conjunction with floors, and roofs, is to provide a barrier between two environments, so that one environment can be adjusted and maintained within acceptable limits.

A wall is a selective separator between two spaces where between an actual or potential flow of energy is involved. The greater the difference between the two spaces the greater is the stress of duty imposed on the wall. Thus, the elements of the wall must be selected so that in the first instance they impart the necessary resistance to keep noise levels within acceptable limits. The way they are arranged, however, is also important. This will determine the variation in conditions throughout the wall. Interaction between various factors involved may produce conditions within the wall structure that require special attention.

The panel 13 may be a standard plaster board sheet which is provided in association with the panel 14 of the present invention. The surface modifications 12 may be provided

preferably within the cavities provided between two panels 14, 13. Alternatively the panel 14 may present the surface modifications outwardly for positioning facing a frame structure. The surface modifications will provide a disruption to the sound waves endeavouring to travel into the panel 14 from any sound transmitted from the inwardly facing surface of the panel 13. To prevent direct vibrational transmissions between the two panels a spacer 15 of a low hardness material such as a foam or rubber is provided to create a space lamination such may be provided at appropriate locations between the panels 13 and 14. This spacer will reduce the incidence of material vibrational transmission of sound.

The panel 14 is preferably mounted to a frame work structure 16 of a building such as timber framing directly, or with rubber or foam spaces in between or by way of mounts 17. Such mounts may be rails of an extruded or roll formed kind to which the panel structure of the panels 13, 14 are mounted. Rubber grommets 21 or strip material may be further provided intermediate of the structure 16 and the mounts 17 and/or between the mounts 17 and the panel 14. With reference to Figure 5, there is shown a detailed view of the arrangement wherein the panel is provided to a timber framing structure as for example shown in Figure 16.

A putty like material may be provided to overlay the positions where the fastening means 22 may be provided to secure the panel 14 to the rails 17. The application of such a putty 23 provides a sound seal to the migration of sound via the fastening means 22 to or from the other side of the panel 14 to which it is provided.

With reference to Figure 6, a wall utilising the panel construction of the present invention may be provided wherein a plurality of panels are provided adjacent to each other. Such a plurality of panels 20 are preferably engaged to adjacent like panels as for example shown in Figure 4. A sound sealing material 25 may be provided intermediate of the panels to thereby reduce transmission of vibration between adjacent abutting panels.

The spacer seal 15 may extend around or approximate to the formed perimeter of the plurality of panels. Intermediate of the spacer there may be provided a sound absorbing putty 26. Such a sound absorbing may also be provided external of the seal 15.

The exterior panel 13 may preferably be adhered to the panel 14 by adhesive regions 27 such as adhesive daubs. The adhesive is that which holds the facing panel 13 to the inner panel 14.

With reference to Figure 7 there is shown a double sided wall structure which includes a frame structure of a first row of studs 102 and a second row of studs 106. The studs preferably

extend from floor to ceiling of a building structure and nogs or dwangs may extend between adjacent studs in each row. However most preferably each row remains separated from the other row and accordingly a gap 107 is provided between the rows of studs. The gaps will reduce the possibility of solid mass sound transmission, between studs and hence each side of the wall.

On each side of the studs are provided a wall panel sub assembly. Each wall panel sub assembly preferably consists of a first panel 101 and a second panel 100. In a most preferred form the panel 101 is of a kind as hereinbefore described which utilises the cavity structure defined by the anhydrate material therein. The first and second panels are engaged to each other but are separated by a space therebetween which is preferably defined by a spacer element 104 which is of a flexible material such as a foam or rubber strip or strips. The foam may for example be a high density foam seal. As mentioned above, additional adhesive daubs may be provided intermediate of the two panels of each sub assembly to fix these together. As a sub assembly, the two panels are then fixed to the appropriate side of the frame structure to a respective row of studs.

Preferably a high density foam seal is provided intermediate of the stud and the facing side of the first panel 102 to act as a vibration absorption spacer between the studs and the subassemblies. Fixing screws can then extend through the subassemblies (through both panels 101 and 100 to further fix the sub assemblies to the frame work). Screws of a sufficient length and of a kind often used in a plaster board panels can be used.

Intermediate of the two sub-assemblies of panels a thermal insulation material such as a fibre insulation mat can be positioned to further enhance sound absorption and to provide thermal insulation.

In the most preferred form the sub assemblies are positioned such that the non planar (e.g. the surface with the cobbled or prismatic upstands) panel of the sub assemblies are positioned engaged to the frame structure, facing the studs or facing the cavity between the studs. The non planar surface 108 positioned in this manner will encourage the sound dissipation within the cavity between the two facing sub assemblies, provided on each side of the frame structure.

It is perceived by the inventor that these wall structure as shown in Figure 7 may utilise one only subassembly on one side only and the other side may be of a different kind. A single stud arrangement against which a single sub assembly is provided may also be utilised.

However it has been recognised in testing that a double wall structure as shown in Figure 7 and wherein the spacing between the interior facing surfaces of the wall sub assemblies provided at approximately 170mm apart, provides a very attractive absorption characteristic of which reference will hereinafter be made.

Tests

In order to achieve high STC valves it has been recognised by the inventor that, important factors, in addition to masses of the component layers, are the depth of air space, the use of sound absorbing materials within the air space and the rigidity of the mechanical coupling between the layers. This may be achieved by a wall assembly with no significant rigid mechanical connection between the two wall panel subassemblies on each side of the frame structure. The mechanical connection between the subassemblies of two panels is reduced by the use of separate rows of studs to support the subassemblies independently of each other.

With reference to Figures 11, 12 and 13 test results indicate that the cavity panel incorporating sub-assembly of this invention reached an STC of 63 dB. This value is higher than those reached with locally and internationally (Canada and USA) produced acoustic panels of solid (non cavity) configuration. The STC of Standard Commercial Wall Boards is 54 dB.

For the wall assembly of Figure 7 the results also showed a significant improvement to the lower ranges of frequency (between 50 – 160 Hz). This effect can be avoided by increasing the air space between the non-continuous wooden frames to displace the facing surfaces of the two subassemblies. Tests were conducted to find the optimum airspace between the facing surfaces of the panel subassemblies on each side of the frame structure to suppress resonance. This was found to be optimum at 170mm.

It was shown by analysis that the core shear parameter has a significant effect on the noise transmission characteristics of the proposed panel, which has better sound transmission characteristics than a homogenous panel, for two reasons: first, the coincidence frequencies are shifted to higher frequency ranges, and second, the coincidence transmission loss is considerably increased due to the presence of the cavities on the layer surface.

Tests were conducted on the new panel at the University of Auckland Acoustic Laboratories. Sound transmission loss was measured by testing in two separate rooms highly reverberant not in solid contact with either of them. A loud speaker and amplifier are used to generate random sound in one of the rooms and sound energy passes through the partition into the second receiving room (Figure 10):

The level in the receiving room is partly determined by the area of the partition and the total absorption of the receiving room. The larger the sound transmission class (STC) value, the better the partition (less sound energy passes through it).

The reverberation time in the echoic chambers was optimised. The reverberation time is directly related to the room volume and inversely related to total absorption in the room. The reverberation time is calculated using Sabine reverberation time equation:

$$RT = 0.161\ V/(\alpha\ S + 4\ m\ V)$$

where:

V is the room volume in cubic meters,

α is the mean absorption coefficient,

S is the total surface area of the room, in square meters,

m is the energy attenuation constant per meter due to air absorption.

An important improvement is achieved on the low frequency range (between 50 – 160 Hz). On curve of Figure 11, the variation of the transmission loss is shown with frequency:

- For low values of frequency (between 50 – 160 Hz) the transmission loss curve follow the mass law. It shows significant improvement.
- At mid-ranged frequencies (between 200 – 630 Hz) a deviation from the mass law takes place. This is attributed to the fact that at this range the wave resonance acts to increase the frequency values. The larger the air space between the double layers or the heavier the materials, the lower the frequency at which resonance occurs.
- For higher frequency ranges, the transmission loss curve follows the mass law again. The curve shows that the TL is significantly higher at intermediate frequency range (1000 – 2000 Hz). This is mainly due to the fact that the coincidence frequencies are much higher than for the larger values of frequency. A sharp drop in LT is noticed between (2000 - 2500 Hz) to then increase rapidly with increase in frequency (2500 – 4000 Hz).

To maximize the improvement due to airspace, frames should be designed so that the mass-air-mass resonance is at the lowest frequency as possible. Many common frame designs

do not meet this criterion. The air trapped in the space between the layers acts as a spring transferring vibration energy from one frame to the other.

The concept of sound transmission of prismatic surface cavitated core of a wall barrier is of a significant importance in the research for more cost effective methods related to development of acoustic wallboards.

The sound transmission losses of a single or double layer walls are determined by the physical properties of the component materials and the method of assembly.

We believe that noise management of the whole system will dictate whether the subsystems will perform satisfactorily. Furthermore, it is estimated that the major failures can be avoided by proper design and suitably implemented wall barriers. The rate of noise failures can be reduced effectively if corrective measures are taken by the whole industry.

Summary of the measurement of airborne sound insulation of building elements regarding the results of figures 11-13.

INSTALLATION OF TEST SAMPLE:

The wall under test is installed in the opening between two reverberation chambers – chambers C and A for a wall, chambers A and B for a floor. These chambers are vibration isolated from each other which results in a structural discontinuity at the middle of the test opening. This gap is covered over by a collar, which seals the gap and provides for each of fixing of samples. The wall sample is constructed by the client following the techniques normally used in practice for that type of wall or floor/ceiling, and is sealed into the test opening with perimeter seals of acoustic sealant. For each of removal, the surfaces of the test opening are covered with an adhesive, heavy fabric tape prior to the construction of the building element.

METHOD:

The measured transmission loss values are obtained in accordance with the recommendations of ISO standard 140-3:1995(E) "Laboratory Measurement of Airborne Sound Insulation of Building Elements" using a B&K 2133 analyser. The measurements were repeated and checked by an independent measuring system, the B&K 2260 sound level meter.

Essentially the transmission loss of a building element is measured by generating sound on one side of the building element (the source chamber) and measuring how much sound is transmitted into the receiving chamber. In the source chamber pink noise is radiated from a

loudspeaker. Time and space averaged sound pressure levels in both the source and receiving chambers are measured by using a rotating boom microphone, and the average sound pressure levels are obtained by sampling the sound pressure levels as the boom rotates through one cycle (taking 32 seconds).. This is repeated for a different loudspeaker position in the source chamber.

Measurements of the background noise levels in the receiving chamber are also made. Then, should it prove necessary, the transmitted noise levels are corrected for the influence of background noise as prescribed in the standard.

The sound absorption of the receiving chamber is also determined by measuring the reverberation times (ISO-354:1985(E) "Measurement of Sound Absorption in a Reverberation Room").

RESULTS:

The third octave band sound reduction indices R are presented in both table and graph formats. Sometimes a highly reflective test sample means that the lower frequency sound pressure levels cannot be reliably measured; this is indicated by #N/A in the table of results. Additionally, if the specimen is highly insulating, sometimes the background noise affects the measurements, resulting in only an upper threshold being found; this is indicated by a > sign preceding the tabulated results.

Single figure ratings are also presented. The weighted sound reduction index R_w, determined according to ISO 717-1, is presented along with spectrum adaptation terms C_{tr} and C. R_w is determined by fitting a reference curve to the third octave band sound reduction indices R from 100Hz to 3150Hz, and gives a single figure rating of the sound reduction through the building element (higher is better). The spectrum adaptation terms are added to R_w and are used to take into account the characteristics of particular sound spectra. C is used for living activity noise, children playing, railway traffic at medium and high speed, highway (>80km/h) road traffic, and jet aircraft at short distances. C_{tr} is used for lower frequency noise such as urban road traffic, low speed railway traffic, aircraft at large distances, pop music, and factories which emit low to medium frequency noise. C and C_{tr} without further subscripts are applied to a frequency range of 100Hz to 3150Hz. Other spectrum adaptation terms are provided with enlarged frequency ranges (if measured), e.g. $C_{tr,50\text{-}5000}$ is applied to urban traffic noise with a frequency range of 50Hz to 5000Hz. For light timber constructions C_{tr} will be negative, indicating the poor sound insulation abilities of such constructions at low frequencies.

The sound transmission class (STC) determined according ASTM E413 is also presented. This is determined by fitting a reference curve to the third octave band sound reduction indices R from 125Hz to 4000Hz, but in a slightly different way to ISO 717-2. The sound transmission class gives a single figure rating of the sound reduction through the building element so that higher is better.

TABLE 1

Gauge	Type	Weight Per Thickness
Body(8.5mm)	Swelled anhydrates	1.42 kg/m^2
(i) Face (2mm) (ii) Backing Face (2mm) (iii) Body (8.5mm)	Hardened (EPA)	19mlt/m^2 76 mtl/m^2 Nil
Body gauge surface	Fibre-glass strands	220 gms/m^2

TABLE 2

Gauge	Type	Weight Per Thickness
Body (8.5mm)	Swelled anhydrites	1.54 kg/m^2
(i) Face ((2 mm) (ii) Body (0.5mm) (iii) Backing Face (2mm)	Hardener (EPH)	61.7 mlt/m^2 185.2 mlt/m^2 61.7mlt/m^2
(i)Face layer (ii)Body layer	Fiber-glass strands	24 gms/m^2 208 gms/m^2